**Article**

# Congruence of Energies for Cerebral Photon Emissions, Quantitative EEG Activities and ~5 nT Changes in the Proximal Geomagnetic Field Support Spin-based Hypothesis of Consciousness

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## ABSTRACT

The hypothesis by Hu & Wu that networks of nuclear spins in neural membranes could be modulated by action potentials was explored by measurements of the quantitative changes in photon emissions, electroencephalographic activity, and alterations in the proximal geomagnetic field during successive periods when a subject sitting in the dark imagined white light or did not. During brief periods of imagining white light the power density of photon emissions from the right hemisphere was about $10^{-11}$ $W \cdot m^{-2}$ that was congruent with magnetic energy within the volume associated with a diminishment of ~7 nT as predicted by the dipole-dipole coupling relation across the neuronal cell membrane. Spectral analyses showed maxima in power from electroencephalographic activity within the parahippocampal region and photon emissions from the right hemisphere with shared phase modulations equivalent to about 20 ms. Beat frequencies (6 Hz) between peak power in photon (17 Hz) and brain (11 Hz) amplitude fluctuations during imagining light were equivalent to energy differences within the visible wavelength that were identical to the intrinsic 8 Hz rhythmic variations of neurons within the parahippocampal gyrus. Several quantitative solutions strongly suggested that spin energies can accommodate the interactions between protons, electrons, and photons and the action potentials associated with intention, consciousness, and entanglement.

**Key Words:** photons, consciousness, nuclear spin networks, geomagnetic intensity, spectra analyses, cosmology, electroencephalographic activity, extracerebral representation of memory.

## 1. Introduction

Contemporary concepts of consciousness and modern neuroscience are converging towards the mechanisms and processes established in the late 19th century and early 20th century by quantum theorists and experimentalists. Most of the complex molecular processes that appear to govern neuronal changes coupled to brain functions converge on a quantum of approximately $10^{-20}$ J (Persinger, 2010). Primary phenomena ranging from the energy equivalence of the potential differences between the potassium ions associated with the resting membrane to the change in voltage that defines the action potential are associated with this "neuronal" quantum. Hu and Wu (2004) developed a testable model that nuclear spin networks in neural membranes could be

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modulated by action potentials through the subtle and indirect dipole-to-dipole coupling (J-coupling) between two nuclear spins that emerge from discrete interactions between nuclei and proximal electrons.

Recently we (Dotta et al, 2011a) showed that photon emissions from depolarizing cell cultures (removed from incubation temperatures) were primarily emitted from the plasma membrane. If spin is a fundamental quantum process with an intrinsic connection to the morphology of space-time, then Hu and Wu's (2004) concepts could be manifested through photon emission during specific brain activity. The concept that photons are not only a primary correlate of neuronal activity but may occur as photon fields which *are* the visual experience was developed by Bokkon (2005) and verified experimentally (Wang et al, 2011). The quantitative energetic relationships between the photon emission, frequency-specific cerebral activity, and alterations in the adjacent geomagnetic field in which the person is immersed should be congruent and might reveal a method to pursue the hypothesis that quantum entanglement originates from the primordial spin processes (Hu and Wu, 2006). That light, gravity, and geomagnetic changes are intercalated would have significant implications for how information within the brain is represented in extracerebral space (Persinger, 2008) as well as maintained over extraordinarily large durations of time.

## 1.1. Previous Research

The potentially powerful coherence between the electromagnetic frequencies associated with the visible wavelength and cerebral functions, including consciousness and thought, has been strongly suggested by experimental and correlational studies. Kobayashi et al (1999a) found that baseline photon emissions from rat brains were between $\sim 10^{-11}$ and $10^{-12}$ $W \cdot m^{-2}$. The value decreased by about 60% of baseline levels following a protracted period of hypoxia. During hyperoxia (100% $O_2$ inhalation) photon emission intensity was enhanced by 130% relative to baseline particularly over the frontal regions (Kobayashi et al, 1999b). Theta wave power within slices of hippocampus, the gateway to declarative memory, was coupled to the intensity of the photon emissions.

In four separate studies (Hunter et al, 2010; Dotta and Persinger, 2011; Dotta et al, 2012; Saroka et al, 2013) we have found significant increases in photon emissions primarily from the right hemisphere (rarely from the left) while people sat in complete darkness ($\sim 1 \cdot 10^{-11}$ $W \cdot m^{-2}$) and alternatively thought about a bright white light or random experiences. Our basic experimental design has been a triplicate procedure where by the subject repeats the process of "resting" (imagining no bright light (30 s)) and imagining projecting white light (30 s) in tandem sequences three times in order to verify reliability. The intensities of the photon emissions from the right hemisphere were strongly (0.90) correlated with the total EEG power for all bands over the left prefrontal region only during the periods when the subjects were "imagining white light" (Dotta et al, 2012).

The original experiment (Hunter et al, 2010) with an individual who generated conspicuous photon emissions as measured by analogue photomultiplier tubes (PMT) from his right hemisphere while imagining a white "cosmic" light demonstrated a significant inverse correlation between the intensity of the horizontal geomagnetic field (perpendicular to the temporal plane) and the intensity of photon emission. Decreases over 10 to 15 s of 15 nT and 5 nT at 0.25 m and 1 m from the right side of his head were associated with the same magnitude of energy ($10^{-11}$ J) that was associated with the net increase in photon emissions during that period. This energy, assuming each action potential is associated with $1.9 \cdot 10^{-20}$ J, would be the equivalent of the activity of about 1 billion neurons. The human cerebral cortices contains in the order of 20 to 40 billions of neurons.

Replication of that study with another subject during simultaneous measurement of photon emissions while imaging white light (Saroka et al, 2013) and geomagnetic intensity 0.25 cm from the right hemisphere verified the inverse correlation between increased photon emissions and decreased intensity of the adjacent geomagnetic field within the horizontal plane. Factor analysis indicated both variables loaded significantly (0.62, -0.83, respectively) on the same factor. Neither the correlations nor this factor structure emerged during the instructed intervals when the person was not imaging white light. The slope of the equation indicated that for every 10 nT decrease in the intensity of the earth's magnetic field in the horizontal plane there was an increase of $0.5 \cdot 10^{-11}$ $W \cdot m^{-2}$ in photon emissions from the subject's right hemisphere.

The present study was designed to replicate and to extend the previous research by measuring the phenomena from the subject's right hemisphere by a digital photomultiplier unit, quantitative electroencephalography, and magnetometer *simultaneously* while she engaged in repeated intervals of imagining white light compared to not imaging white light. We reasoned that if the relationship between the three domains of measurement were as reliable and robust as what we had measured, employing dozens of subjects, previously, the effects should be both conspicuous and repeatable within a single setting.

## 1.2. Calculations and Inferences

According to Hu and Wu's (2004) prescient interdisciplinary hypothesis, nuclear spin networks in neural membranes are associated with relatively strong fluctuating internal magnetic fields that are modulated by the action potential through indirect dipole-to-dipole coupling or J-coupling. The process is defined as the indirect scalar interactions between two nuclear spins which emerges from the discrete interactions between local electrons and their associated nuclei. J-coupling reveals information about bond distances and angles and, when applied to Nuclear Magnetic Resonance spectroscopy, allows the inference of information regarding the connectivity of molecules. It is not unusual for J-coupling or proton-to-proton couplings to be reflected within the frequency range shared by electroencephalographic activity of the human brain. According to Hu and Wu the J-coupling frequencies between $^1H$ and $^1H$ are in the range between 5 and 25 Hz.

The magnetic dipole strength between magnetic moments associated with spin is classically described by:

$$B=(\mu_o m)\,(4\pi r^3)^{-1},$$

where $\mu_o$ is the permeability of free space, m is the magnetic moment and r is the distance between the dipoles. The nuclear (proton) magneton displays a magnetic moment of $1.41 \cdot 10^{-27}$ $A \cdot m^2$. For the distance of 1 nm, the width of a membrane channel, the resulting magnetic field is $3 \cdot 10^{-6}$ T. However across the cell plasma membrane of approximately 10 nm, the internal magnetic fields that could be displayed would be in the order of $\sim 3 \cdot 10^{-9}$ T or 3 nT. The actual value could range between 1 and 9 nT depending upon the precision of μ. For air (N,O), which is slightly paramagnetic, it is $1+3.8 \cdot 10^{-7}$. For water, which is slightly diamagnetic, the relative permeability is $1-9 \cdot 10^{-6}$. Consequently Hu and Wu's hypothesis predicts that the magnetic fields associated with spin-related, J-coupling across the plasma membrane should be about 5 nT. The energy associated with photon emission should be equivalent to this value.

From Hu and Wu's perspective as well as that of Penrose (1960) spin is a fundamental quantum process with an intrinsic connection to the structure of four dimensional space-time. The spin angular momentum of any system has been quantized as:

$$S=h \cdot 2\pi^{-1}\sqrt{(s(s+1))},$$

where "h" is Planck's constant ($6.6241 \cdot 10^{-34}$ J·s) and the values for s are n/2 or 0, ½, 1, 3/2… . From contemporary views all known matter, composed of fermions, have s=1/2. Hence the value would be $0.92 \cdot 10^{-34}$ J·s. To result in an energy that is within the range of the net change in voltages (-90 mV to -70 mV to +50 mV) associated with an action potential (1.9 to $2.2 \cdot 10^{-20}$ J), the frequency required would be between 2.1 and $2.4 \cdot 10^{14}$ Hz which is equivalent to a wavelength (assuming c, the velocity of light in a vacuum) between 1.24 to 1.44 μm. This is the typical width of a synapse (1 to 2 μm) within the human brain. When the slight attenuation of c ($\sim 2 \cdot 10^8$ $m \cdot s^{-1}$) within brain space is considered, the value is remarkably close to Bohr's distance for the relationship between the fine structure frequency (obtained from velocity) or the time for one orbit of an electron around a Bohr magneton and the masses of the proton and electron which he quantified as: $f=1.32\ \omega_o\sqrt{mM^{-1}}$ where $\omega_o$ is the fine structure frequency of $6.2 \cdot 10^{15}$ Hz, m is the mass of an electron and M is the mass of the proton.

The spin for photons is s=1 which would be associated, according to the above equation, with $1.49 \cdot 10^{-34}$ J. For an action potential with an energy equivalent of $2.2 \cdot 10^{-20}$ J the equivalent wavelength would be 2.03 μm. The difference in wavelengths between the latter value and those associated with action potentials (1.24 to 1.44 μm) is equivalent to a range between 590 and 790 nm. This includes, effectively, the visible spectrum that is primarily measured by photomultiplier units. This convergence suggests that spin between particles particularly protons and their J-couplings should be associated with intrinsic field strengths somewhere between 1 and 10 nT. Associated emissions of photons from neuronal cell membranes should match, when surface area and volume are accommodated, the energy coupled to those changes.

# 2. Method and Materials

## 2.1 Subject

The subject was a 28 year old female graduate student in Psychology. She is First Nations Mushkegowuk Cree from James Bay, Ontario and is also of mixed European ancestry (from mother's and father's side, respectively). She has been a meditation practitioner for approximately 5 years and a Level II Reiki practitioner for two years.

## 2.2 Procedure

We applied the procedure that reliably shows the relationship between thinking about white light while sitting in darkness and the photon emissions from the right side of the head. The subject sat facing east (as determined by declination) in a comfortable arm chair that was housed in an industrial acoustic chamber that was also a Faraday cage. The chamber windows were covered with thick black terry cloth towels such that when the lights were extinguished in the chamber and in the room containing the chamber, the background intensity of ambient light was less than $\sim 10^{-11}$ $W \cdot m^{-2}$. We had found that when the background ambience is higher magnetic field-evoked photon emissions from cells either do not occur or are not measureable (Dotta et al, 2013).

The Sens-Tech LTD DM0090C digital photomultiplier unit was placed and supported by a platform composed of cardboard 15 cm from the temporal plane of her head. The sensor of the MEDA FVM-400 Vector magnetometer (with the X-plane perpendicular and the Y-plane parallel to her head) was also placed 15 cm away and was situated about 5 cm away from the PMT. Repeated measurements demonstrated no discernable artifacts from within either instrument during their operations. The subject wore a 19-channel Electro-Cap with sensors placed according to the 10-20 International Standard of Electrode Placement; impedance for all sensors were below 5 kOhms and bandpass filtered between 1.5 and 50Hz. The appropriate impedance of the sensors was verified. All three computers that measured photon emissions, quantitative EEG, and the three planes of the proximal geomagnetic field were stationed outside of the chamber. Each of the first three authors operated one of the measurement procedures.

After the chamber door was closed, the subject and one of the experimenters communicated only through the lapel microphone and speaker system. She was asked to think about sending light out from her consciousness into the sensor of the PMT for about 2 min which was followed by 2 min of relaxation. The procedure was repeated four times with a rest of about 5 minutes between the 2 min-2 min pairs in order to reset some of the equipment (from outside of the chamber). The numbers of photons were sampled 50 times per second (20 ms $\Delta t$) while the EEG data from all sensors were sampled at 250 times per second. The geomagnetic field measures were sampled 3 times per second. The differences in collection times were limited by the software associated with the different equipment. We selected 2 min sequences for measurement rather than 30 s, employed in previous studies, to ensure time for the cognitive processes to maximally affect the photon emissions.

### 2.3 Data Extraction and Analyses

Data collected from the photomultiplier unit was completed by a Lenovo Thinkpad laptop computer with a Windows 7 operating system. Counting was conducted with Sens-Tech Limited application software. Data was saved with this software, extracted, and then imported to SPSS 17 for analyses. Brain activity was monitored continuously using a Mitsar-201 quantitative electectrographic amplifier. Data collection was completed using WinEEG software. The software supplied with the magnetometer that sample the intensity (to the nearest nT) in each plane 3 times per second was downloaded for PC SPSS analyses.

For the QEEG approximately 20 second segments of raw data were collected from the beginning of each baseline and subsequent imagination conditions; a total of five trials (10 epochs) were extracted. This data was then imported into MATLAB for the computation of mean spectral analysis function within successive 1-Hz frequency bins from 1 to 25 Hz for each sensor using the *bandpower* function. The sum of power within each frequency bin was taken for the left and right hemispheres by adding all the left (Fp1,F7,F3,T3,C3,T5,P3,O1) and right (Fp2,F8,F4,T4,C4,T6,P4,O2) hemispheric channels. We also computed sLORETA activation scores for the left and right parahippocampal regions. This was completed with the sLORETA ROI function for each 1 Hz increment between 1 and 25 Hz as well as for conventional frequency bands between delta and gamma. This data was then imported into SPSS for further statistical analysis. All statistical analyses of the data from the different measurements were completed by PC SPSS 16. Specific types of analyses for examination and their rationales are included in the Results section.

## 3. Results and Comments

### 3.1 Quantitative EEG

There was marked increased in power within the delta (1 to 4 Hz) band and the low beta to gamma band (13 to 35 Hz) associated with bilateral activation within the parahippocampal gyri within both hemispheres during periods when light was imagined compared to the non-imagining intervals (rest periods). Because of the redundancy of differences, particularly within the 1 Hz increments of the beta and gamma bands, factor analyses were completed. Two factors emerged. The first factor was associated with bilateral activation of the parahippocampal region within the beta-gamma band (eigen value=7.5; 47% of variance explained). Figure 1 clearly shows the increased power within these bands during each interval the subject imagined white light. One way analysis of variance indicated there was significantly [$F(7,39)=22.57$, $p < .001$; omega$^2$ estimate=83% of variance explained) more power within this band during the imagining compared to the “non imagining” periods. (The first trial was not included because of the marked continuing decrease in photon emissions.)

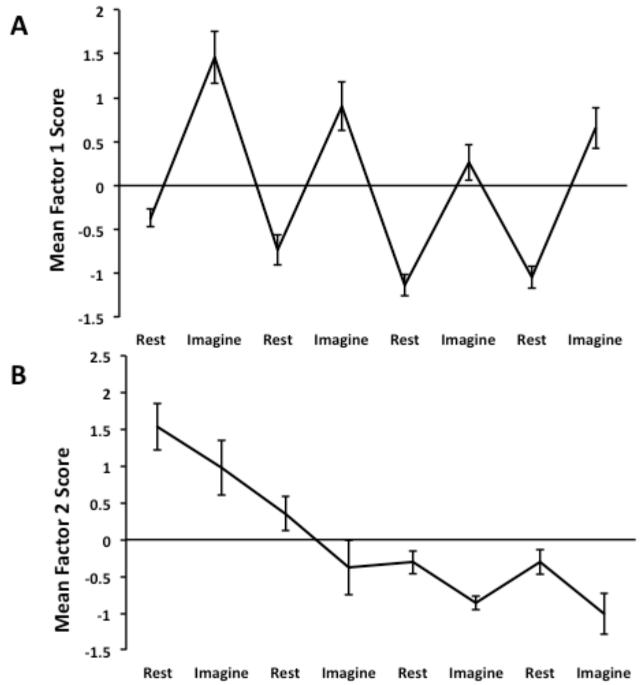


**Figure 1. Factor (z) scores for quantitative electroencephalographic activity from the parahippocampal region of the subject's brain within: A) the beta-gamma frequency range, and, B) the delta frequency range during successive intervals of resting ("mundane" thoughts) and imagining white light. Each interval was 120 s. Vertical bars indicate standard deviations.**

On the other hand, the second factor showed that the power within the delta band gradually declined as a function of time during the experiment. The factor that contained the variables associated with this deactivation over time bilaterally within the delta range was smaller (eigen value=2.1) and explained less of the variability (13%). The difference in z-score means over time was significant statistically [$F(7,39)=10.97$, $p <.05$].

## 3.2. Photon Emissions

The results of the digital PMT measurements are shown in Figure 2. In order to facilitate comparison, z-scores were completed based upon the numbers of photon counts during the previous interval. A z-score of 0.1 is equivalent to ~43.5 photons (range 16-65) per 20 ms ($\Delta t$). The numbers of photon counts for each of the 15 s successive intervals of the 120 s of measurement are shown. Only during the first 15 s of each of the 4 trials where white light was imagined was the photon emission significantly higher than the equivalent first 15 s of the resting trials. There was no significant difference between the imagining and not imaging white light for any of the subsequent 15 s segments of the blocks of trials.

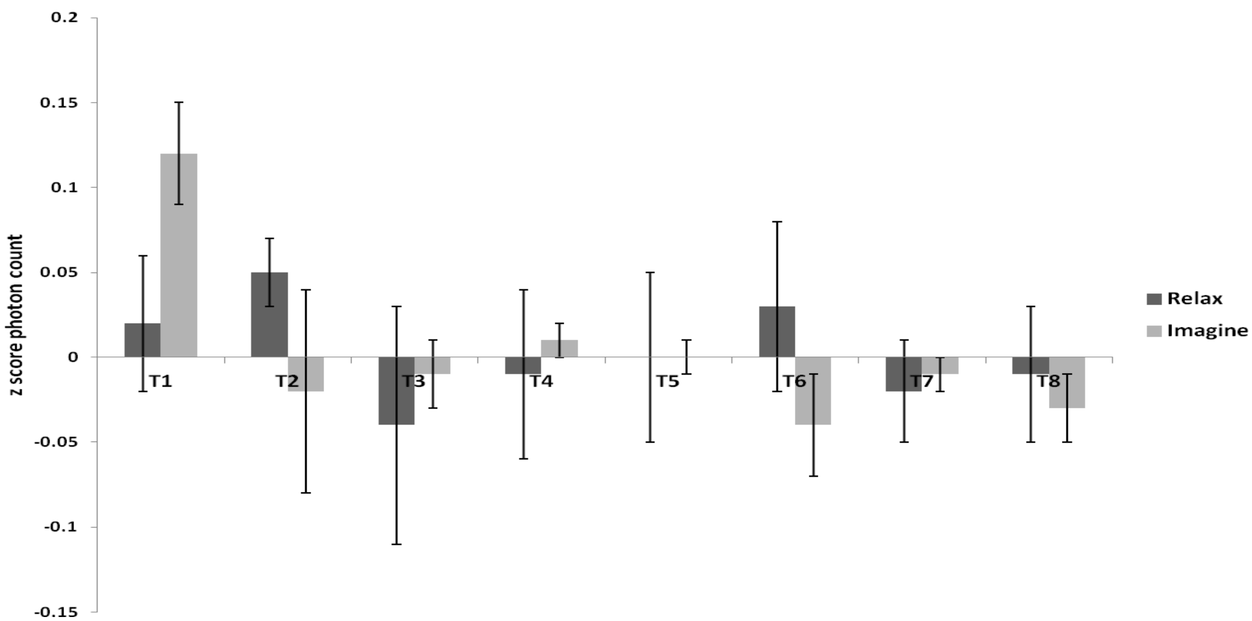


**Figure 2. Mean z-scores for changes in photon counts for each of the 8, 15 s segments during the 5 pairs of imaging white light vs not imagining white light. The only significant difference occurred during the first 15 s. Vertical bars indicate standard deviations. 0.1 SD=435 photons per 20 ms.**

The increase in numbers of photons in standard units (~1.1) would be ($4.6 \cdot 10^1$ photons$\cdot$ $\Delta t^{-1}$)$\cdot$($5 \cdot 10^1$ $\Delta t \cdot s^{-1}$) or $2.3 \cdot 10^3$ photons$\cdot s^{-1}$. In the above context the surface area of the sphere at 15 cm away from the subject's head is $0.9 \cdot 10^3$ larger than the aperture of the PMT. When considered in equivalent $m^2$ the average would be ~$1.7 \cdot 10^6$ photons per s. Assuming a central energy for photons of $4 \cdot 10^{-19}$ J$\cdot$photon$^{-1}$ (mid wavelength), the value would be ~$0.3 \cdot 10^{-11}$ W$\cdot m^{-2}$. This value is within measurement error of what we found with analogue PMTs in previous studies. The background, when she was not imaging, would be approximately 50 times less or within the range of cosmic ray energies ($10^{-13}$ W $m^{-2}$).

Spectral analysis of the photon emissions during the 15 sec (750 Δt measurements) after the instructions to either image white light or to rest was completed for the differences between each of the periods when light was being imagined compared to the previous baseline for each of the pairs (trials) of observations. There were no conspicuous frequency profiles that visibly defined the two conditions, except for the marked paucity of power within the 7 Hz to 9 Hz range during the imaging periods.

Visual inspection of the profiles however indicated narrow frequency "windows" where the power spectra for the photon emissions for the imagining periods were correlated across time whereas the corresponding baseline periods were not. To formally analyze this observation, successive Spearman rho correlations (to minimize the effects of extreme values) of the raw power values for each of the periods (no-imagining, imagining of white light) as a function of frequency were completed as a function of the 0.05 Hz increments. Only the interval between 15 Hz and 17 Hz displayed statistically significant (rhos between 0.46 and 0.57, dfs=38, $p < .001$)

intercorrelations between the light imagining periods while corresponding baseline values were not significant statistically (rhos between .15 and .17).

In order to discern where the maximum differences occurred across the power spectrum the differences scores were converted to z-scores for each of the trials. Only those power values from the spectra that were greater than the absolute value of 2 standard deviations (above or below the mean) were converted in to 1s while all other (lesser) values were set equal to 0s. We employed the absolute value because we assumed that either a marked increase or decrease in photon emissions between the imagining vs the previous baseline interval could reflect functional significance.

Visual inspection of the trains of 0s and 1s as a function of each frequency unit (total=384 increments) between 0.27 Hz and 25 Hz (the Nyquist Limit for 50 samples per second) indicated that there was an increase in the deviation of photons emitted for all of the trials (pairs) in the following range: 2.27 to 2.74 Hz, 5.41 to 6.61 Hz, 16.5 to 17.9 Hz, 21.6 to 24.6 Hz. The total mean numbers of extreme changes in photon emissions as a function of 1 Hz intervals between 1 and 24 Hz for all trials combined are shown in Figure 3. (Because there were 15 increments per Hz, the actual number of events would be multiplied by 15). The typical standard error of the mean was about .12. The most conspicuous feature was the statistically significant elevation of extreme deviations in photon emissions during light imaginings between 16 and 17 Hz. This is within the range of $^{1}H{\cdot}^{1}H$ coupling predicted by Hu and Wu and suggests the importance of the proton in this process.

The numbers of sequential frequency increments with a value of 1 were within the range expected by chance. However the proportion of fractional Hz increments that contained 2,3,4, 5, or >5 (there were only two) successive series of 1s were 28%, 38%, 20%, 11%, and 3%, respectively. The equivalent frequency for 2 to 4 successive 1s, was between 0.2 to 0.4 Hz. Within the frequency band of 5 and 24 Hz this fraction of 1 Hz would be equivalent to the range of 10 to 25 ms with a median duration of 20 ms. This value is often associated with the recursive cohesive potentials associated with consciousness that move over large areas of the cortical manifold in a rostral to caudal direction (Llinas and Pare, 1991; Llinas and Ribary, 1993). In other words during intervals when white light was being imagined phase changes in the frequency of the amplitude fluctuations of the photon emissions associated with the recursive creation of consciousness increased compared to the previous baseline or resting mentations.

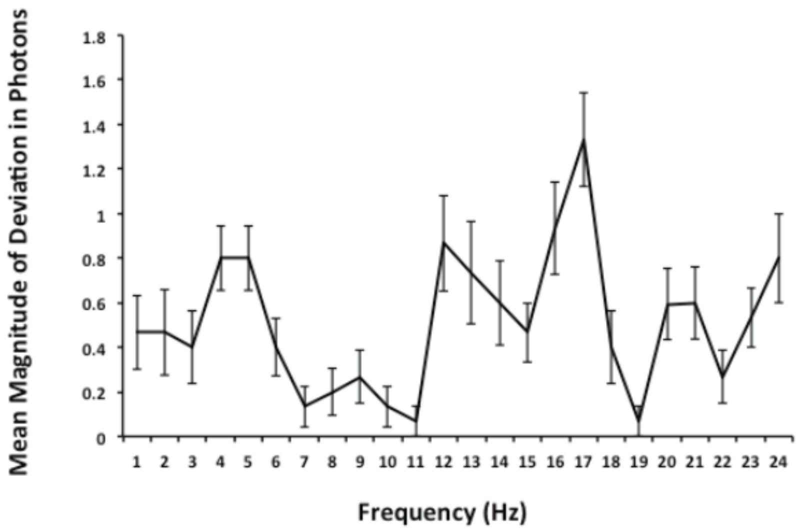


**Figure 3. Mean numbers (multiply by 15 for total) of photon emissions (or absorptions) > 2 standard deviations around the running mean per 1 Hz increment. Vertical bars indicate standard deviations.**

## 3.3 Comparisons Between Photon and QEEG Data

The most conspicuous feature of the photon emissions during the experiment was the decline in absolute power over the sessions as shown in Figure 4. This pattern was very similar to decline in the factor scores for the power within the delta EEG range shown in Figure 1. Figure 4 shows the z-scores based upon the quantitative measures of

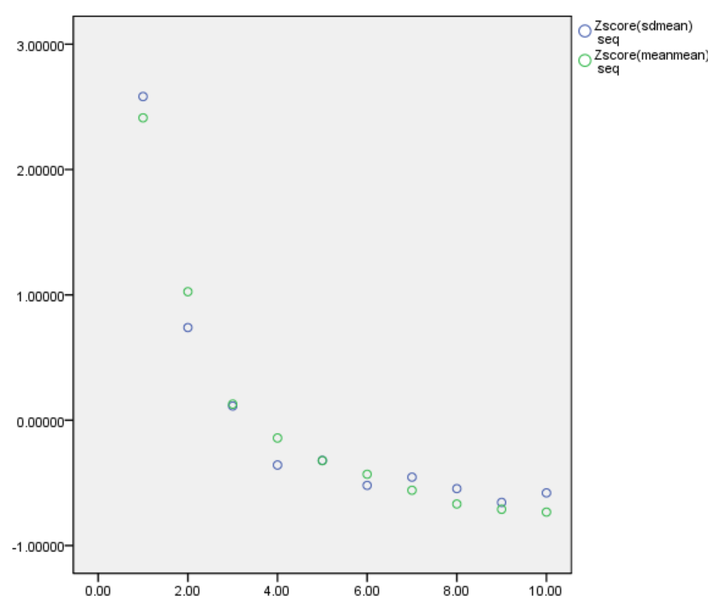


**Figure 4. Z-scores (standardized scores) for the mean numbers of photons (50 samples per s) and standard deviations for those numbers recorded during successive 120 s segments for the 10 trials (5 pairs of intervals of imagining and not imagining light).**

absolute "raw" numbers of photon counts for all 10 measurements (5 pairs of imagining-non-imagining) for the means and standard deviations for each measurement. Both the means and dispersions (standard deviations) decrease by about 3.5 standard deviations (z-scores) over the session. The greatest change was after the first pair of trials.

To discern if there was any temporal coupling between the numbers of extreme deviations in photon emissions and electroencephalographic power, the total power for each 1 Hz increment between 1 and 24 Hz from the left and right hemispheres were obtained. To allow direct comparisons with the photon data the power for the 1st 15 sec of each imagining interval was subtracted from the 1st 15 s from the previous rest interval. The means of the differences were also calculated. As can be seen in Figure 5, there was a moderate strength (~0.55) correlation between the QEEG power over the left hemisphere and photon emissions (over the right hemisphere) for the first trial only. The EEG power differences for the second and third pairs were not significant statistically (not shown).

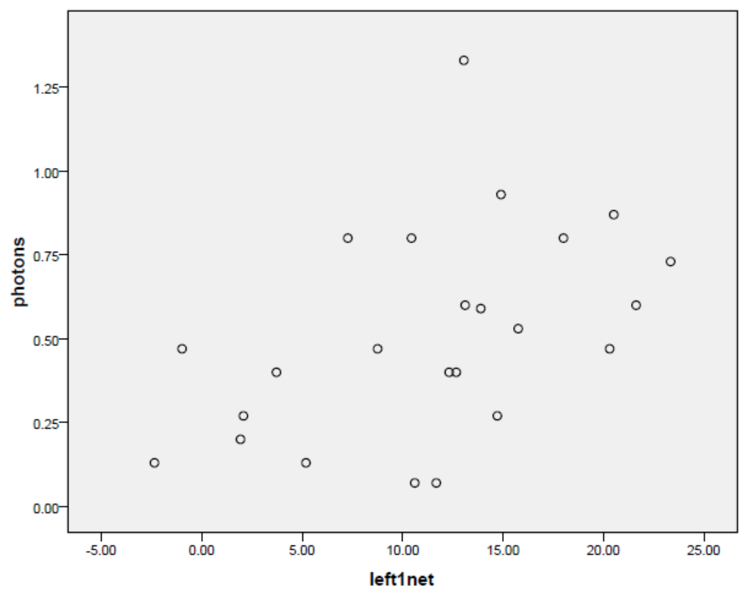


**Figure 5. Scattergram between the numbers of temporal increments (multiply by 15 for actual values) per 1 Hz with increment of z> 2.0 deviations for photon emissions between the first 15 s intervals associated with imagining light compared to the previous interval (not imaging) and the difference in total electroencephalographic voltage for the left hemisphere (leftnet) per 1 Hz increment for µV changes between the first 15 s of imaging light compared to the first 15 s of the previous interval.**

Given the observations with Sean Harribance (Hunter et al, 2010), who showed marked increased activity within the paraphippocampal regions when he was engaging in imagining light associated with "receiving" information about the cognitive history of other people, the power only from the left and right parahippocampal region was obtained for each of the 1 Hz frequency increments. Although there was no significant correlation between the photon emission measures and QEEG power for any of the single trials, there was a significant correlation (rho=0.54) for all trails combined between the power ranges over the left parahippocampal region and photon emissions. Stated alternatively, only the standardized scores for all of the trials for the *spectra* of the EEG and photon emissions were significantly correlated.

We calculated the differences in the z-scores per Hz for the power for the left and right parahippocampal region and for the photon emissions. The results are shown in Figure 6. A positive score indicates that relatively more of the total power over the frequencies occurred for photon emissions while a negative score indicates that relatively more power over the range of frequencies occurred within the electroencephalographic activity. It is clear from the positive slope that relatively more of the EEG power occurred within its lower frequencies while more of the photon emission numbers occurred within the higher frequencies. When the 24 1 Hz increments were divided into two populations, one below 13 Hz and one above 12 Hz, there was clear evidence that significantly [$F(1,22)=17.75$, $p <.01$, omega$^2$ equal 31%] more of the power (M=0.83, SEM=0.27) from photons occurred within the higher frequency band than the lower frequency band (M=-0.83, SD=0.42) compared to the greater proportional power in the lower (<12 Hz) frequency band for the electroencephalographic activity.

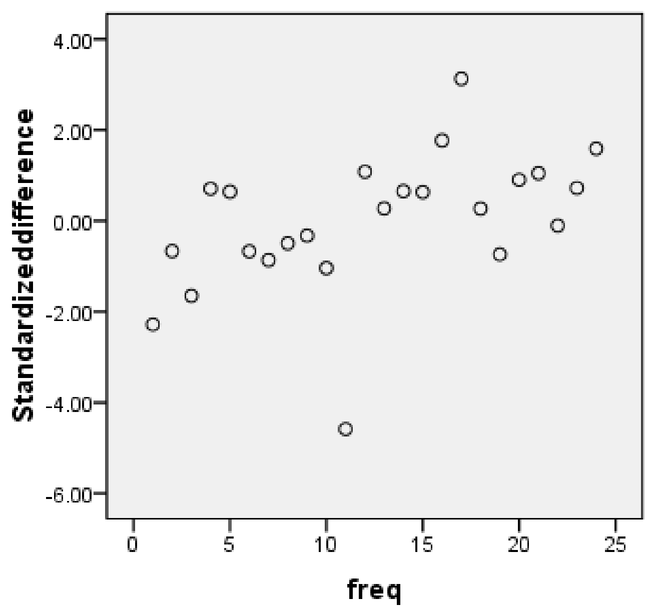


**Figure 6. Differences in z-scores for the average of the z-scores for the left and right parahippocampal electroencephalographic power vs the z-scores for the numbers of extreme photon emissions (from the right hemisphere) as a function of frequency between 1 and 24 Hz.**

In Figure 6 the conspicuous paucity of power within the changes in EEG power at 11 Hz between the previous non-imaging and imagining sequences is evident. On the other hand, for photon emissions, the only deviation from normality, that is more than 2 standard deviations, was at 17 Hz. The difference between these two frequencies, 6 Hz, might be considered a beat frequency within the theta range. Some approaches have suggested that certain states of consciousness may be associated with the "beat" frequencies, or their harmonics, that are generated by the cerebral cortical activity within the two hemispheres. It is relevant that for bipolar measurements of EEG activity between the two hemispheres the actual pattern is the time-varying potential difference of the voltage fluctuations between the two sensors over the two hemispheres which is effectively a beat frequency.

### 3.3. Changes in Proximal Geomagnetic Field Intensity

The correlation (r, rho) between the change (in nT) for the horizontal component of the geomagnetic field and the numbers of photon counts for the 2 min intervals was strongly negative (-0.90, -0.83, respectively). This effect was similar to what we have measured in two previous studies (Hunter et al, 2010; Saroka et al, 2013).

The novel pattern revealed in this study was the reliable diminishment of the range in variability of geomagnetic intensity along the caudal-rostral plane of the subject's cerebrum while she was imagining white light compared to when she was not. Figure 7 clearly shows the maximum range in change of the earth's magnetic field intensity parallel to the long axis of her brain during the 10 successive, 2 min durations. B refers to the "before" periods (no imaginings) and L refers to the imagining intervals. For trials 2 through 5 (the first is not included because of the markedly deceasing rate of change in the photon emissions) the z-scores for the photon emissions were 1.38, 1.56, -0.52, 1.46, 0.27, 2.17, -0.98, and 1.47, respectively. Consequently the decrease in the change of the intensity in the geomagnetic field was clearly associated with an increased cerebral photon emission.

The mean decrease in range during the intervals of imagining white light was about 7 nT. This value is within the range predicted by Wu and Hu's spin-spin interaction model for the proton over the distance that defines the plasma membrane. Spectra analyses revealed peaks in power for periods of about once every approximately 10 s.

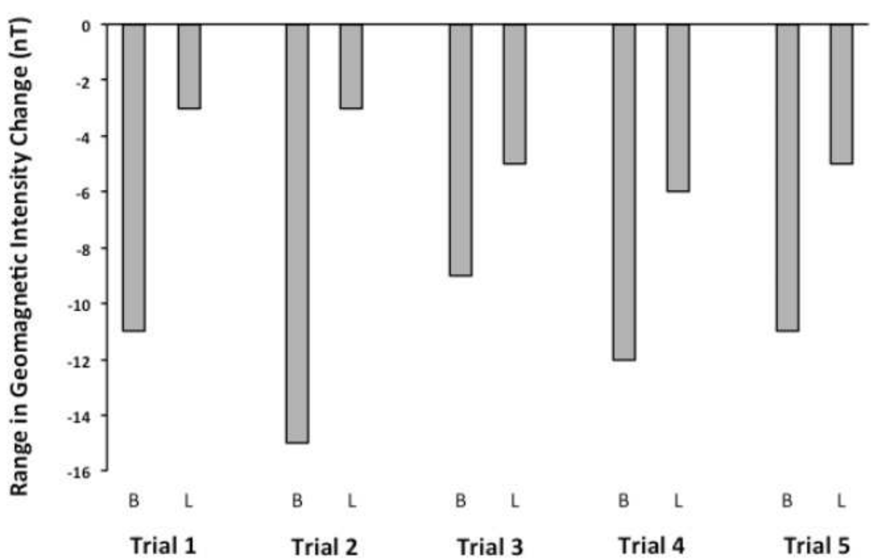


**Figure 7. Range in change in the parallel (to head) component of the earth's magnetic field during no imaging (B) and imagining white light (L) durations (each 2 min). Note that the range of change was marked diminished with each imagining interval.**

If the mean decrease of ~7 nT variation was related to the reliable increases in photon emissions during the first 15 s of each episode of imagining light then the magnitude for their energies within the functional volume occupied by the subject's cerebrum (radius equal 21 cm, i.e., radius of the cerebrum+15 cm) and the measurement sphere should be similar. The diminished fluctuation in the domain parallel with the cerebrum would be associated with a decreased energy of $B^2 \cdot (4\pi\mu)^{-1}$ $m^3$ or $(7 \cdot 10^{-9})^2$ $T^2 \cdot (2 \cdot 10^{-6}$ $N \cdot A^{-2}) \cdot 1.4 \cdot 10^{-2}$ or $7.2 \cdot 10^{-13}$ J. The area of the "sphere" defined by the measurement radius would be $5.4 \cdot 10^{-1}$ $m^2$ such that energy per area would be $1.3 \cdot 10^{-12}$ $J \cdot m^{-2}$. Only 2 Hz (1/s) would be required to result in a power density of $2.6 \cdot 10^{-12}$ $W \cdot m^{-2}$. An increase in this value was measured from the photon emissions during periods of imagining white light while a decrease in variability of the geomagnetic field during these periods was associated with a comparable magnitude of energy. This convergence strongly suggests that the energy increase from the light emission and the energy decreases from the diminished variability in the ambient geomagnetic field shared the same source of variance.

# 4.0 General Discussion

## 4.1. Summary and Interpretations of Present Study

The results of this study replicate and extend the results of previous measurements that a specific state of consciousness associated with imagining white light displays convergent energies that correspond to the changes in the intensity of the geomagnetic field around the brain. The subject in this experiment exhibited the reliable ability to increase and decrease photon emissions from the right side of her brain that was reflected in the increased power within the beta and gamma range of activity. Relative measurements of the largest deviations in photon emissions also occurred across this broad range. These changes were reflected in the reversible decrease and increase in the range of change in the proximal (at 15 cm from the head) intensity of the geomagnetic field in the plane parallel to the subject's rostral-caudal axis.

The average change in intensity was 7 nT which is precisely within the range of the values predicted by Hu and Wu's (2004) model for proton-proton interactions or J-coupling within the neural membrane that is coupled with the action potential. The energy associated with this change in magnetic field strength at the distance measured from the cerebrum was equivalent to $\sim 10^{-11}$ $W \cdot m^{-2}$ which was the same order of magnitude as the increase in energy associated with the photon emission. We suggest that the approximately 7 nT decrease in geomagnetic intensity along the rostral-caudal plane that corresponded with the equal increase in photon emission indicates that the energy from very small changes in the proximal intensity of the geomagnetic field, action potentials associated with neuronal activity, and cerebral photon emissions derive from the same (or very related) shared source of variance.

One process by which this interaction could occur was revealed in the directional component of the change in the geomagnetic field. The reliable decrease in intensity during periods of imagining light vs not imagining light occurred in the caudal-rostral direction parallel to the long axis of the subject's brain. Llinas and his colleagues (1991;1993) had observed that the electromagnetic fields associated with consciousness move as an integrated wave or field over large cerebral surfaces along a rostral-to-caudal direction once every ~20 ms with phase modulations between ~10 and 20 ms. One simple model is that the recursive rostral to caudal cerebral waves interacted with the geomagnetic field in this plane to produce interference patterns. Similar to a hologram, the photons generated from this process were emitted as a photon field.

This intrinsic 20 to 25 ms or "40 Hz" gamma band has been associated with consciousness and has been discussed by several thoughtful authors (Edelman, 1989; Nunez, 1995; McTaggart, 2001). The duration is closely commensurate with the time required for action potentials to complete the pathway or circuit that includes the hippocampal formation and cerebral cortices in the human brain. One would expect such a powerful duration to be represented within photon fields associated with action potentials if one were causal or both if there were a shared third variable. In the present study the median number of successive fractional Hz units from the spectra analyses was 3 or the equivalent of 0.2 to 0.4 Hz. For the mid range of electroencephalographic activity measured in this study this would be equivalent to a superimposed ripple of about 40 to 45 Hz, that is, peak-to-peak durations of between 25 and 20 ms, respectively. From one perspective the appearance of this duration superimposed upon the base frequencies could be considered a form of phase modulation. Superimposition of faster frequencies upon a slower baseline is a conspicuous property of hippocampal neurons. An approximately 40 Hz ripple (the "primary modulation mode" of the cerebral cortices) is superimposed upon the fundamental ~7 Hz theta band periodicity of the pyramidal cells within Ammon's fields. The hippocampus both accesses and receives input from the entire cortical manifold through its connections with the entorhinal cortices of the parahippocampal region.

That an interference or "beat" pattern, which is the subtraction of two simultaneously applied frequencies may have occurred, was suggested by the marked reciprocal differences in relative power within the electroencephalographic output from the parahippocampal region and the right hemispheric photon emissions. The z-score of approximately -4 for electroencephalographic activity around 11 Hz and the opposite value +2.5 (or +4 if the adjacent 16 Hz is considered) at 17 Hz for photon emission would result in a beat frequency of ~6 Hz. This is well within the theta range which has been associated with multiple altered states. Although this beat value is about 1.8 Hz lower than the classical Schumann resonance generated within the earth-ionosphere cavity (in air), it may be instructive that the velocity of light from which this is calculated and occurs within water (the primary medium of brain space) is $2.6 \cdot 10^8$ $m \cdot s^{-1}$ and hence the equivalent frequency would approach 6 Hz. In addition higher order modes of the fundamental frequency of about 8 Hz are separated by ~6 Hz (Schlegel and Fullekrug, 1999).

A less known feature of the earth-ionospheric phenomena has been the detection of line splitting of the Schumann resonances. According to Tanahashi (1976) there is a split of about 0.2 Hz in the Schumann peak, i.e., 7.8 Hz and 8.0 Hz, although this can range between 0.2 and 0.4 Hz in the first mode and 0.1 to 0.6 Hz in the second mode. The significance of the splitting has not been explored. It may be possible that the duration of the spectral patterns of the photon fields being generated by the subject's brain, whose integrated frequency was also in the range of 0.2 to 0.4 Hz, and was equivalent to the ~20 ms duration or "40 to 45 Hz" band associated with consciousness, could reveal a mechanism by which information could be interfaced between the two resonating systems. It is not spurious that the fundamental frequency for both the human cerebrum (assuming a bulk velocity of ~4.5 $m \cdot s^{-1}$ and a circumference of 0.6 m) and the earth (velocity of light and $4 \cdot 10^7$ m circumference) would converge to an identity within the normal distribution of cerebrums on this planet.

If consciousness is recreated every ~20 ms through these recursive electromagnetic fields traversing the cortical manifold, then the velocity of this movement along the rostral-caudal axis of about 14 cm of the average cerebrum would be ~7 $m \cdot s^{-1}$. A frequency of 6 Hz, would require a "circle" with a circumference of 1.2 m. In our present experiment the photons and geomagnetic intensities were measured at a distance whose equivalent spherical diameter from the center of the subject's brain would have been 1.3 m. If this convergence is valid, the 6 Hz detected would reflect a type of moving field rotating around the subject's head at the distance of measurement.

The potential "beat" frequency of 6 Hz when applied to the wavelength of light discerned by the PMT is not a trivial energy. The energy associated with a frequency of $5.45 \cdot 10^{14}$ Hz (550 nm) is $36.1 \cdot 10^{-20}$ J. A difference of only 6 Hz ($5.39 \cdot 10^{14}$ Hz) results in an energy of $4.97 \cdot 10^{-21}$ J. The change in energy for a 6 Hz increment at 790 nm, is $4.0 \cdot 10^{-21}$ J. This range of change is very relevant when applied to the intrinsic activity of stellate cells within layer II (*stratum stellare of Stephan*) of the entorhinal cortices within the parahippocampal gyrus, the primary input (the perforant pathway which terminates in the dentate gyrus) and output locus for the hippocampal formation (Gloor, 1997). The most prominent feature of these neurons, in addition to their aggregation into bands and islands of cells that can be observed as small focal convexities (*verrucae gyri hippocampi*) on the cortical surface, is their intrinsic low amplitude oscillations of ~8 Hz of about 2.6±0.5 mV.

The energy equivalence of this change in voltage would be $4.2 \cdot 10^{-22}$ J and when multiplied by the intrinsic frequency (8 Hz) would be $3.4 \cdot 10^{-21}$ J per neuron. This value, given the range in magnitudes for the cells and the dispersion values for our measures, is congruent with the energy associated with the beat difference between the electroencephalographic activity within the parahippocampal area and the brain's photon emissions. The total energy from all neurons (~$10^7$) firing within the parahippocampal region, assuming the unit value noted above, would have been about $10^{-14}$ W. Although apparently convenient, the surface area of this region would be about $10^{-3}$ $m^2$ which would have generated the equivalent of $10^{-11}$ $W \cdot m^{-2}$, which was observed in our study.

Why the parahippocampal gyrus and its primary component the entorhinal cortices would couple structurally with the ambient geomagnetic field, particularly within the right hemisphere must be pursued. In addition to being about 40 g heavier on average, the right hemisphere in general displays slightly more white matter {or "tract systems") and is organized as a large field rather than a cluster of interconnected regions which more accurately represents the left hemisphere. Several correlation studies have shown that changes in power within the electroencephalographic activity of the right hemisphere, especially the temporal and frontal lobes, are associated with changes (increases) in geomagnetic activity even within the range of 20 to 40 nT (Mulligan et al, 2010). The effect is sufficient to alter the threshold for visual phenomena within the upper left peripheral visual field, an indicator of right temporal-occipital activity (Belisheva et al, 1995).

We did not measure a large difference in electroencephalographic power between the left and right parahippocampal region; both areas were associated with the photon emissions. This is not surprising considering the unique connection between the hippocampal gyri through its own interhemispheric pathway: the dorsal hippocampal commissure, which is located in the rostral ventral portion of the splenium of the corpus callosum (Gloor et al, 1993). One would expect marked interactions between the two hemispheres. What is clear is that the left hemispheric electroencephalographic activity, involved with voluntary thinking and the sense of self, may have controlled the photon emission from the right hemisphere as indicated by the significant correlations. Like any correlation, there could be a third variable, not measured, that controlled both the conscious intention and the photon emissions.

The ~7 nT changes in local magnetic field strength associated with the emissions of photons from the subject's brain may involve a more global increment of intensity than suspected. For example, according to Campbell (1997) distribution of the intensities of the interplanetary magnetic field peaks conspicuously between 6 and 7 nT. The typical average increase in geomagnetic variation during the full moon when this mass traverses the tail of the geomagnetic field is ~5 nT. Even the non-potential field within the geomagnetic environment that is often employed to resolve inconsistencies between the gradients for north and east components are in the order of 10 nT (Winch, et al, 2005). That biological systems are sensitive to these intensities was clearly shown by St-Pierre et al (2007). Vulnerability to mortality following seizure induction in weaned rat pups was particularly enhanced when they had been exposed for several days perinatally to 5 nT, 7 Hz fields but not to strengths less or greater than this value.

### 4.2. Implications of the Spin-Spin J coupling Mechanisms

The results of this study, that support Hu and Wu's concepts of spin-spin interactions at the nuclear level and action potentials, evoke several considerations that could be relevant to more profound understanding between quantum phenomena, neuronal activity, and consciousness. These include the possibility that, if microcosm reflects macrocosm, what occurs in the single particle system also is reflected in the multiparticle system, such as the brain. A second possibility is that the relationship between gravity and light may occur as equivalences within certain mass-charge conditions that occur within the human cerebrum. The third possibility is that applications of specific temporal-spatial patterns of magnetic fields might mediate their consciousness-altering effects through the J-coupling process.

The first question is does the cerebrum display the equivalent of magnetic moment ($A{\cdot}m^2$ or $J{\cdot}T^{-1}$)? If we assume a unit time (s) and the equivalence of a square meter, the photon emission energy was $\sim 3{\cdot}10^{-12}$ J. When divided by the mean of the average change in magnetic field intensity of $7{\cdot}10^{-9}$ T the result is the value $4.2{\cdot}10^{-4}$ $A{\cdot}m^2$. There is evidence of a circumferential movement of cerebral cortical electromagnetic energies and forces through cerebral space. Llinas and his colleagues (1991; 1993) as well as Nunez (1995) have shown that large-scale areas over the cerebral cortices display a continuous, recursive regeneration along the rostral to caudal direction once every approximately 20 ms with phase modulation between 10 and 20 ms. In other words it might be described as a rotating cerebral cortical field. We think it is relevant that the "default" mode for introspection is represented primarily within medial structures that include the anterior cingulate and posterior (precuneus) regions that could complete the ellipse-like pathway.

According to classic formula for magnetic moment:

$$[(v\cdot r^{-1})\ (kg\cdot m^2)\ (A\cdot s)]\ \cdot kg^{-2} = A\cdot m^2, \text{ hence,}$$

$$v\cdot r^{-1}=f,$$

If we assume $4\cdot 10^{10}$ neurons (40 billion) each with $10^6$ charges that maintain the resting cell membrane or define the action potential (Persinger, 2010) and $1.6\cdot 10^{-19}$ A·s per charge the cerebral value would be ~$4\cdot 10^{-3}$ A·s (Coulombs). With a cerebral mass of about 1.5 kg and an "analogous" moment of inertia (kg·m$^2$) of $1.5\cdot 10^{-2}$ kg·m$^2$ (assuming cross-sectional horizontal area of $10^{-2}$ m$^2$), the intrinsic frequency is ~10 Hz. This is within the range of the electroencephalographic power peak, the intrinsic resonance of the cerebral volume (~7 to 8 Hz) assuming a bulk velocity of 4.5 m·s$^{-1}$ of information (Nunenz, 1995) and a circumference of 60 cm, and the Schumann resonance of the earth.

The second implication relates to the possible mediation between the phenomena of gravity and geomagnetic (electromagnetism) intensity through the parameters associated with the human brain. Although there have been multiple theoretical pursuits to converge the two phenomena, the relationship may be more of a quantitative equivalence rather than a grand unifying equation (Persinger, 2012a). Within the terrestrial frame, Minakov et al derived (1993) a mathematical intersection between a gravitational wave and the first harmonic of the Schumann resonance, or about, 12 Hz. Vladimirski (1995) measured an enhancement in the order of $10^{-3}$ within G (the gravitational constant) with lower global geomagnetic activity within the 50 to 100 nT range. If we assume linearity, then a diminishment of 10 nT should be associated with an increase in the order of $10^{-4}$.

If G (m$^3$·kg$^{-1}$s$^{-2}$) is to be equal to T (Tesla, magnetic field strength, kg·As$^2$), then one set of transformation dimensions would be (kg$^2$·m$^{-3}$), $\Sigma$(A·s)$^{-1}$, and s (time). In other words one equating relation could be the square of the mass per volume, inverse sum of the charge that constitutes the system, and time. In this context the system is the human cerebrum. For a change of $10^{-4}$ in G such that the value is $10^{-15}$ m$^3$kg$^{-1}$s$^{-2}$ and when multiplied by the square of the cerebrum mass (2.25 kg$^2$) divided by its volume ($1.1\cdot 10^{-3}$ m$^3$), this product multiplied by the inverse of the total charge (which we have calculated previously to be $4\cdot 10^{-3}$ A·s) for one second would be $0.5\cdot 10^{-8}$ T or 5 nT. This is within the range of the diminished geomagnetic intensity that was measured when photon emission occurred from the volume of the subject's brain.

One method to confirm the reliability of an inference is to discern if comparable values emerge with different approaches. If gravity is intrinsically related, then the energies measured from the brain should be consistent with local applications of G. According to Nishida et al, (2000) the fundamental spheroidal modes or background free oscillations within the earth occur in the range between 2 mHz and 7 mHz (periods of 8 min to 2.4 min, respectively) whose peak to peak amplitudes are in the order of 0.5 nGal (nanogalileo), with little frequency dependence (1 nGal=$10^{-11}$ m·s$^{-2}$). This acceleration phenomenon, when applied to the mass of the cerebrum (1.5 kg) and multiplied by its average length (0.12 m), would result in energy levels of ~$1\cdot 10^{-12}$ J. The equivalent per m$^2$ would be $10^{-10}$ J·m$^{-2}$. If the near frequency was 7 mHz, the available power would be in the order of $10^{-12}$ W·m$^{-2}$ which is within the range obtained from the light emission from the subject's cerebrum while imaging white light.

Hu and Wu's concept of spin-spin relationships to consciousness strongly suggest that the entanglement processes would occur primordially, before the emergence of major matter, when presumably the fundamental "phenomena" was light or its physical equivalent. Assuming the upper limit of the rest mass of a photon is $<1\cdot10^{-52}$ kg (Tu and Gilles, 2005) and the cerebrum's mass is 1.5 kg, there would be $0.6\cdot10^{52}$ photon equivalents in a cerebral mass. A reasonable assumption is that the temporal existence of these prephotons would reflect Planck's time of $10^{-44}$ s. Assuming the midpoint of the visible spectrum recorded in this study of $4\cdot10^{-19}$ J there would be $10^{30}$ J per cerebrum but if each existed for $10^{-44}$ s the total integrated energy would be $10^{-11}$ J.

The third consideration of Hu and Wu's concepts is that they are quantitative, involve measureable mechanisms and processes, and should be subject to experimentation. Although quantitative convergence of solutions and theoretical explorations are meaningful and integral components of imagination and exploration, the experiment is the most powerful tool of the scientific method to support contentions and extrapolations. For more than two decades we (Persinger, et al, 2010; Persinger and Saroka, 2013; Saroka et al, 2010) have been examining the effects of weak (nanoTesla to microTesla), physiologically-patterned magnetic fields upon the behavior, subjective experiences, electroencephalographic profiles and inferred alterations of intracerebral activity (by Low Resolution Electromagnetic Tomography) associated with the human brain.

Two separate approaches suggest that the application of the appropriately-patterned magnetic field applied with intensities around 1 to 5 μT might directly affect the processes that mediate the phenomena observed in this study. The magnetic energy stored within the volume of a cell that displays a soma width of 10 μm would be about $10^{-20}$ J. If one assumes the true volume is a factor of 10 larger, because of the massive contribution of dentritic and axonal extensions of the functional membrane, then the energies within each neuron available to the membrane would be within the $10^{-19}$ J range associated with photon (light) emissions.

The second approach, a modification of Faraday's solution, for 3 μT fields with our most effective pattern that involves 3 ms point durations would result in the product of $(3\cdot10^{-6}$ T) $\cdot(3.3\cdot10^{2}$ Hz) and when applied across the surface area of a soma ($3.14\cdot10^{-10}$ m$^2$) would be a voltage of $\sim3\cdot10^{-13}$ V. If the resistance of extracellular fluid adjacent to the cell membrane is 300 Ω cm, then it could approach 0.3 Ω across the distance of the width of a soma, or 10 μm. The current in this "ring" would be $10^{-12}$ A. Application of the Biot-Savart law with $(\mu i)\cdot(4\pi r^2)^{-1}$, where μ is permeability, "i" is the current, and r is the radius of the soma, would result in a "secondary" induced magnetic field strength of ($10^{-19}$ μ·i) divided by $2.5\cdot10^{-11}$ m$^2$ or $\sim0.4\cdot10^{-8}$ T, that is about 4 nanoTesa. This is within the order of magnitude of the magnetic field associated with the spin-spin field strengths across the membrane predicted by Hu and Wu's model as well as our empirical measurements. This would suggest that the strength of these experimentally applied fields could interact or alter the photon emissions.

From the perspective of an energetic and particulate model, the energy stored within the cerebral volume and reflected in each neuronal space contains sufficient quantum to facilitate emission of photons within the visible spectrum. At the same time the *secondary* magnetic fields induced by Faraday-like mechanisms from the primary production of changing electric fields from the transcerebrally-applied fields create the intensity of magnetic fields within the nanoTesla range. Both of these conditions converge to influence the spin-spin processes associated with consciousness. This may explain why this technology has been reported to produce such significant alterations in states of consciousness that would otherwise require pharmacological ingestions in order to be simulated.

### 4.3 Spin, Gravitons, Light Emission from the Cerebrum and Consciousness

Hu and Wu's (2006) spin-mediated theory of consciousness assumes that quantum spin is the "seat of consciousness". Within a dynamic process spins are the interface between the particulate composition of the brain and the energetic or wave functions associated with the electromagnetic fields of cognition. They suggest that spin is the "mind pixel". According to the theory "consciousness is intrinsically connected to the spin process and emerges from the self-referential collapses of spin states; the unity of mind is achieved by entanglement of these mind pixels". Spin is embedded in the microscopic structure of space-time and may be more fundamental than space-time itself. The zitterbewegung associated with spin, according to Hu and Wu (2006) may be responsible for quantum effects of fermions in general.

There are at least two quantitative supports for their hypothesis. First, if we assume the spin=2 for a graviton, according to the description of spin, which is $h \cdot 2\pi^{-1} \cdot \sqrt{(s(s+1)}$, the equivalent wavelength to match the energy equivalence ($\sim 1.9 \cdot 10^{-20}$ J) of the action potential ($0.90 \cdot 10^{14}$ Hz$\cdot 1.06 \cdot 10^{-34}$ J·s) is $3.34 \cdot 10^{-6}$ m. For spin=1/2 for fermions (e.g., protons and electrons), the equivalent wavelength from the energy required to obtain the energy equivalence of the action potential is $1.44 \cdot 10^{-6}$ m. The difference between critical wavelengths for the fermion and the graviton transformations is 1.9 μm. This is precisely the value derived by Bohr from 1.32 $\omega_o \sqrt{m \cdot M^{-1}}$ where m and M are the masses of the electron and proton, respectively and omega is the frequency equivalence of the fine structure velocity. In other words, as required by Hu and Wu's model, the metric of energy difference between the fermion and graviton converges on the universal constant for the relationship between the particles and their motion that constitute our matter.

The second quantitative solution that supports the assumption that spin processes and the correlative entanglements occurred in pre-space-time would require a convergent quantity between the forces derived from the smallest unit of space to the largest unit of space. Such "non-intuitive" relationships have been shown previously. For example Persinger and Koren (2007) showed that the time required for the smallest unit of space, Planck's constant to expand one Planck's length is the age of the universe while the time required for the universe to expand one Planck's length is Planck's time ($\sim 10^{-44}$ s). In other words the largest and smallest unit of space is conjoined by the reciprocally shortest and longest time frames that are within are current quantitative system.

It may be relevant, even from a more qualitative philosophical tradition (Persinger, 1999), that any process requires at least two increments of time (Nyquist limit). Because the increment of time required to discern an increment of space that constitutes a phenomenon is systematically related across measurements, e.g., picosecond temporal measurements are optimal to discern pmeter (atomic) phenomena while ms measurements are optimal for mm (neuronal) phenomena, there will always be one increment of space (the universe) where there would be only one increment of time. Consequently there can be no "process" or "time" according to traditional perspectives. The very beginning as well as the very end would exist simultaneously (Persinger, 2012b).

The Casimir effect, which is closely related to gravitation, is described as:

$$((\pi^2 \cdot 240^{-1}) \cdot \hbar c) \cdot a^4 \text{ multiplied by } (S).$$

In this instance "a" is the separation between the two surfaces and S is the surface area. If we assume "a" is Planck's length, and the area is the surface area of the universe (assuming $r=1.23 \cdot 10^{26}$ m), the total force would be $10.9 \cdot 10^{165}$ N. If the surface area is accommodated by dimensionless parameter A (0.44) for the actual surface area, the value is $4.8 \cdot 10^{165}$ N. In comparison if we assume Persinger's (2009) estimate of the universe's mass, derived from the density of 1 proton$\cdot$m$^{-3}$ which is within the critical limit, of $2.38 \cdot 10^{52}$ kg, and the width of the universe, then application of the square of the Zitterbewugen ($10.4 \cdot 10^{86}$ s$^{-2}$) results in a total force of $6.1 \cdot 10^{165}$ N. This convergence is remarkably meaningful, and suggests that the total force of the entire universe based upon its mass, length and intrinsic vibration is consistent with the force derived from its smallest space applied across the universal surface.

However what is particularly salient for Hu and Wu's approach is the results of the force per unit Planck's volume. Assuming $\sim 3.5 \cdot 10^{183}$ Planck's lengths voxels (unit volumes) in the volume of the universe, there would be $\sim 1.7 \cdot 10^{-18}$ N per voxel. When applied across the neutral hydrogen wavelength (21 cm), the element that composes the major mass of the universe, the energy is $\sim 3.7 \cdot 10^{-19}$ J. The wavelength of this energy (multiplied by Planck's constant and then divided into the velocity of light) is about 540 nm, that is, visible light. These convergences indicate that visible light coupled to the energies of action potentials may be the key to entanglement that first emerged in the distant past. That entanglement occurs between photons or at least distant loci within which they are associated by the electromagnetic properties of separate spaces has been shown several times in the laboratory (Dotta et al, 2011b; Dotta and Persinger, 2012).

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